Magnet Power Supply Stabilization and Checking System development

International Workshop 2002
on
Beam Orbit Stabilization

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SPring-8 / SR / Magnet Group

Source for the Beam Instability from the Magnet Power Supply: Drift, Ripple, Noise,,

1/24Hrs 1/6Hrs 1Hz 60Hz 10kHz 100kHz

Drift
Control Circuit,
Input Power Line

Ripple
Rectifier, Control Circuit

Noise
Switching Device
(IGBT, Mos-FET
Thyrister, Snubber)

Synchrotron(1Hz)

City/Industry Power Consumption Change

Spike Noise by Power Transfer Station Tap change

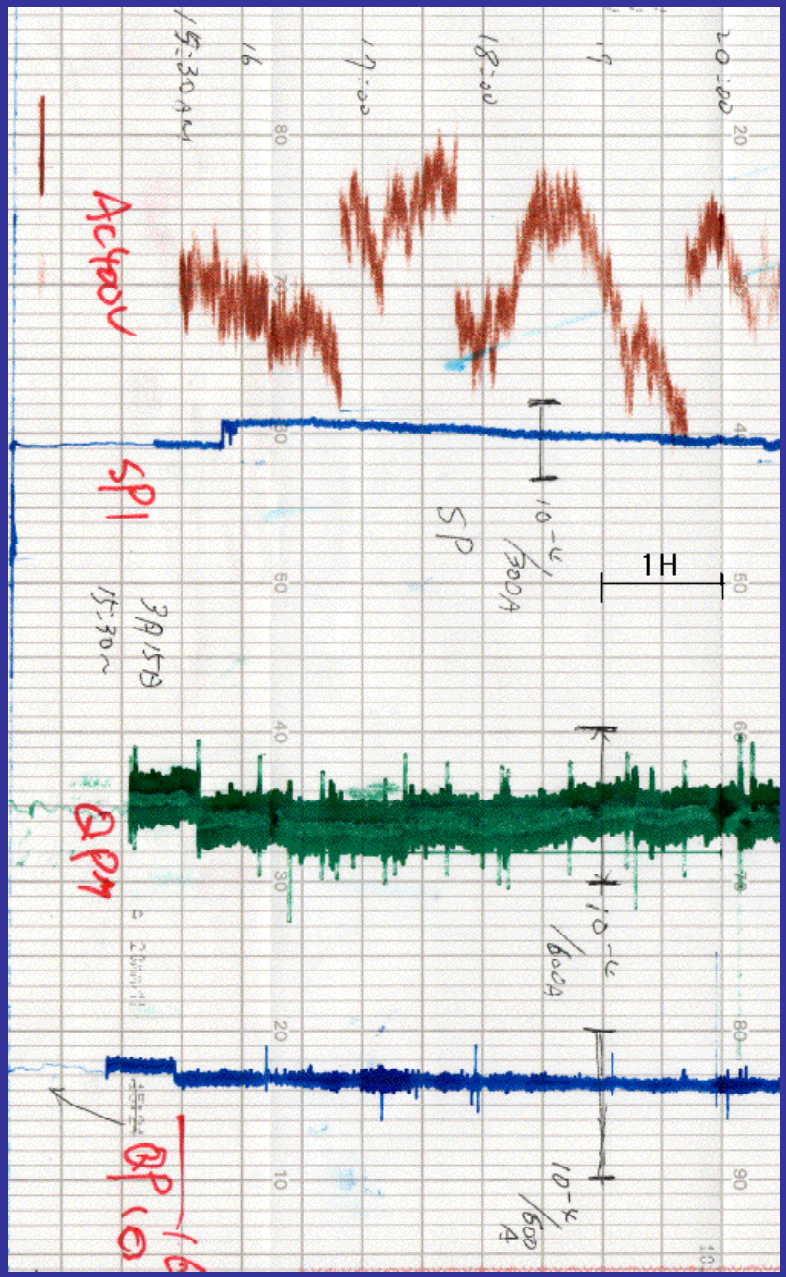
Appendix;

4 Pen Recorder
Chart Graf

(2001 Mar.16)

AC400V, SP1, QP7,
QP10 drift

(30min/cm)



AC400V
Power Station
Tap change 0.6%

SP1

QP7

50ppm

QP10

Effect to Accelerator
Beam Orbit

1/24Hrs 1/6Hrs 1Hz 60Hz 10kHz 100kHz

Slow Orbit Correction

Steering Magnets

Fast Feedback

Steering Magnets

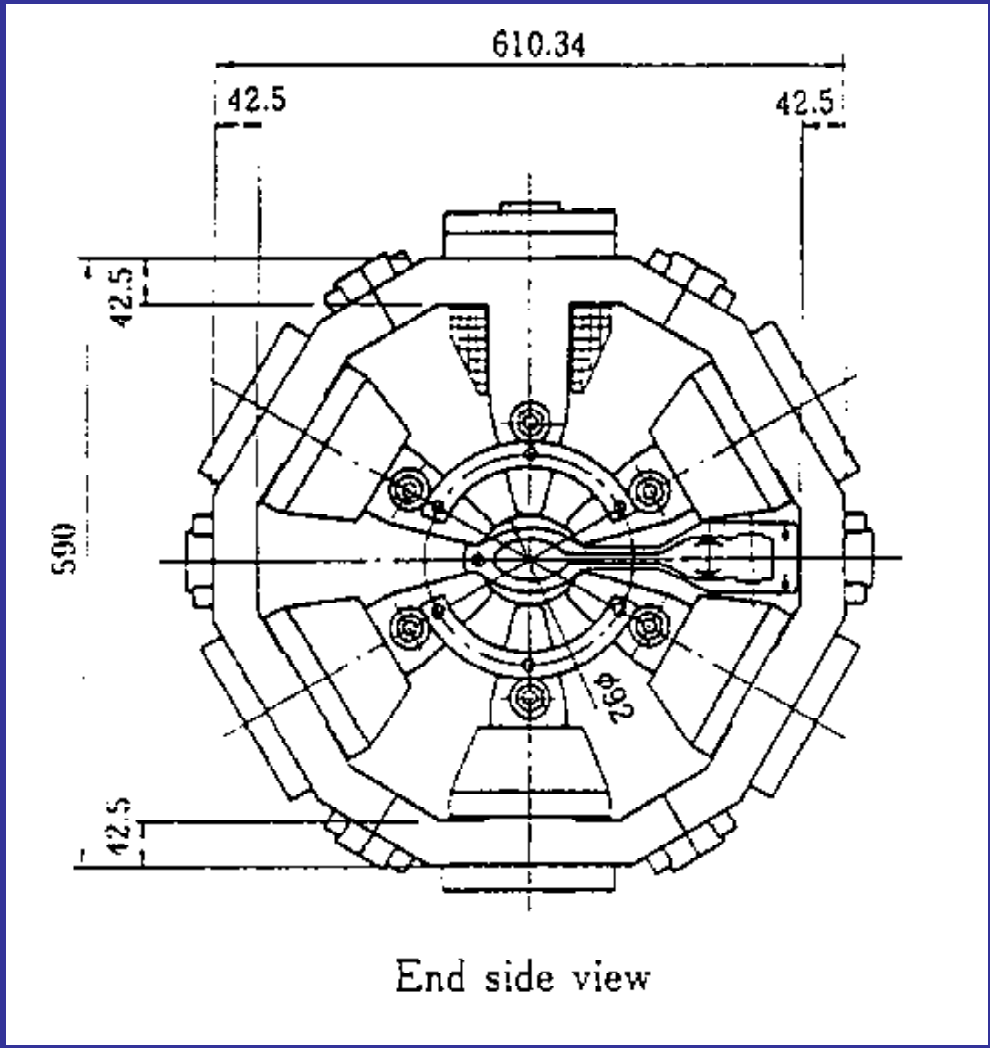
Reduced by Eddy of

Iron Core
Vacuum Chamber

Asymmetry Effect of Chamber

Sx Magnet and Vacuum Chamber

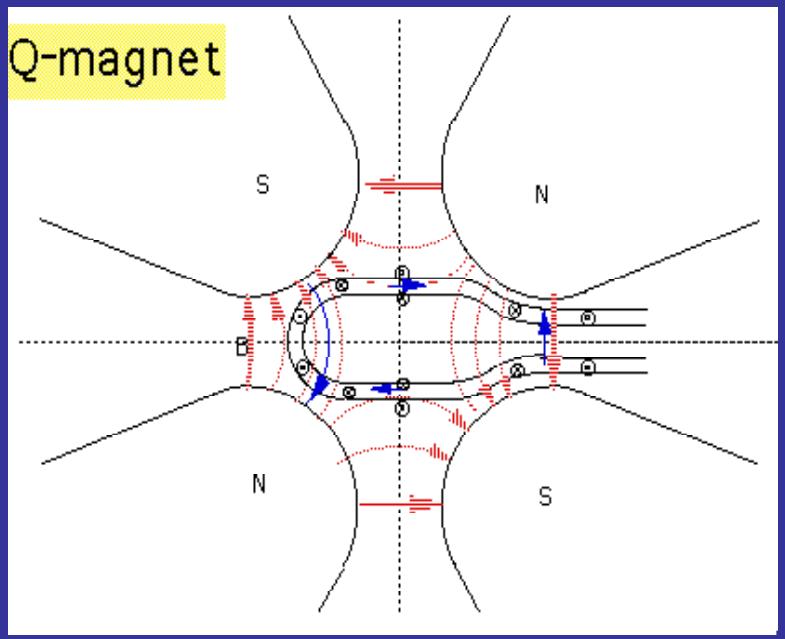
Asymmetry Effect of Chamber

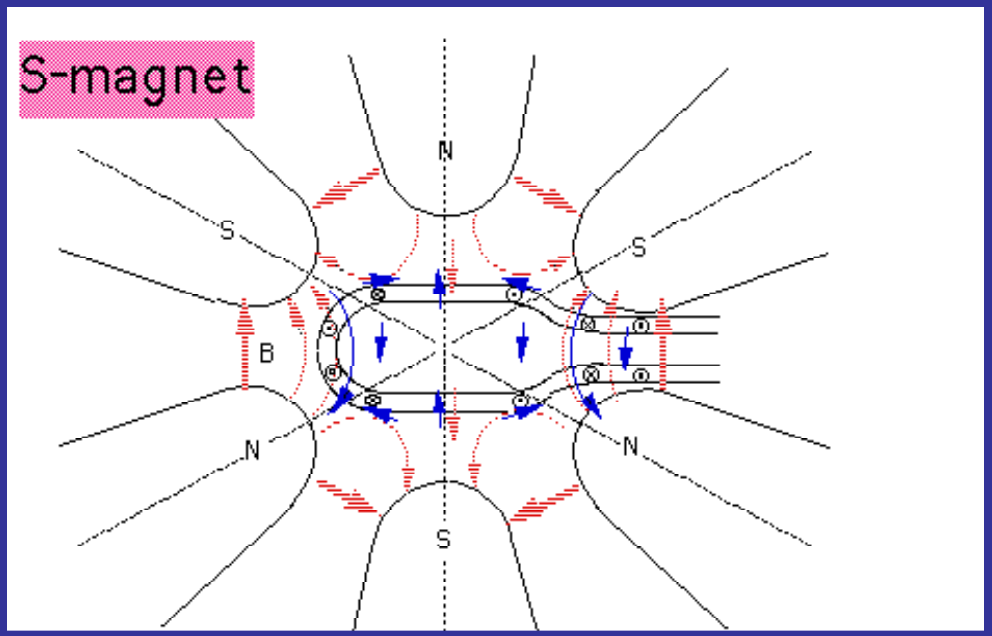


End side view

Asymmetry Effect

Big eddy current in the right chamber causes a beam center field!

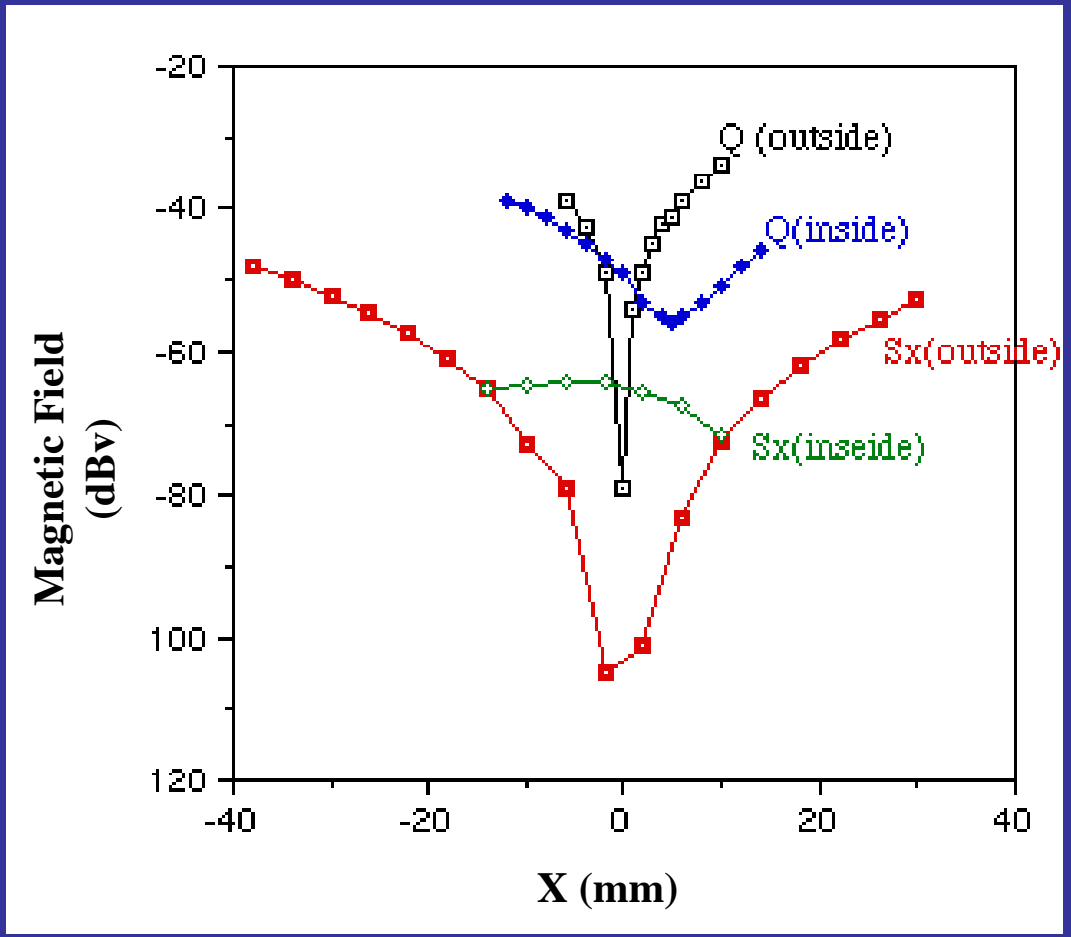




Eddy Current of the Vacuum Chamber in the Q andSx Magnet

Asymmetry Effect of Chamber

Ripple Field inside and Outside of theVacuum Chamber



Q and
Sx magnet

Ripple Field
Measured by 2500t
1cm coil

Magnet :
60Hz AC
current=3.4A

Cf: Riken
Acc.Progr.Rep.Vol.25
(1991)p207

Required Stability of Magnets

Magnet:	1st Design '89	PS Spec. '91
BP:	100ppm	100ppm
QP:	1000	100
SP:	1000	100

Required Stability has changed smaller,
because of the asymmetry effect of the chamber.

Part 1

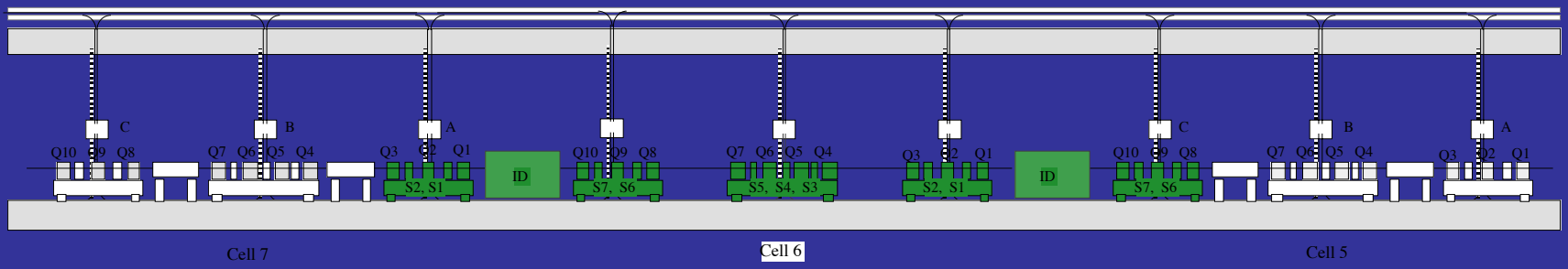
Improvement of Magnet Current Stability (QP)

30m Long Straight Section Installed to SPring-8

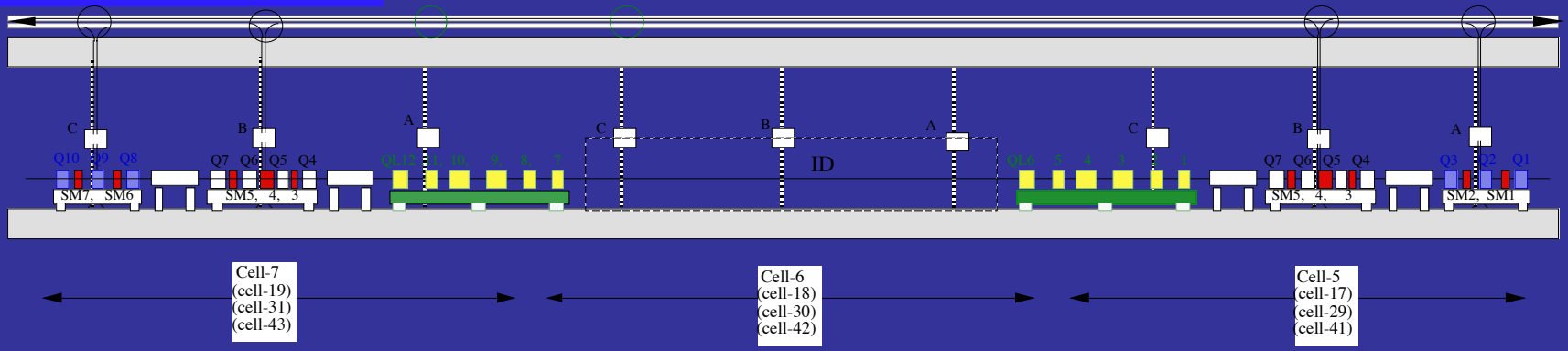
July 2000

2000.6 Takebe/SPring-8

Before Jul. 2000



After Aug. 2000



Magnets were removed July 2000 at 30m-LSS

PS Voltage Down (9% or 25%) (4～12 Cells/48)

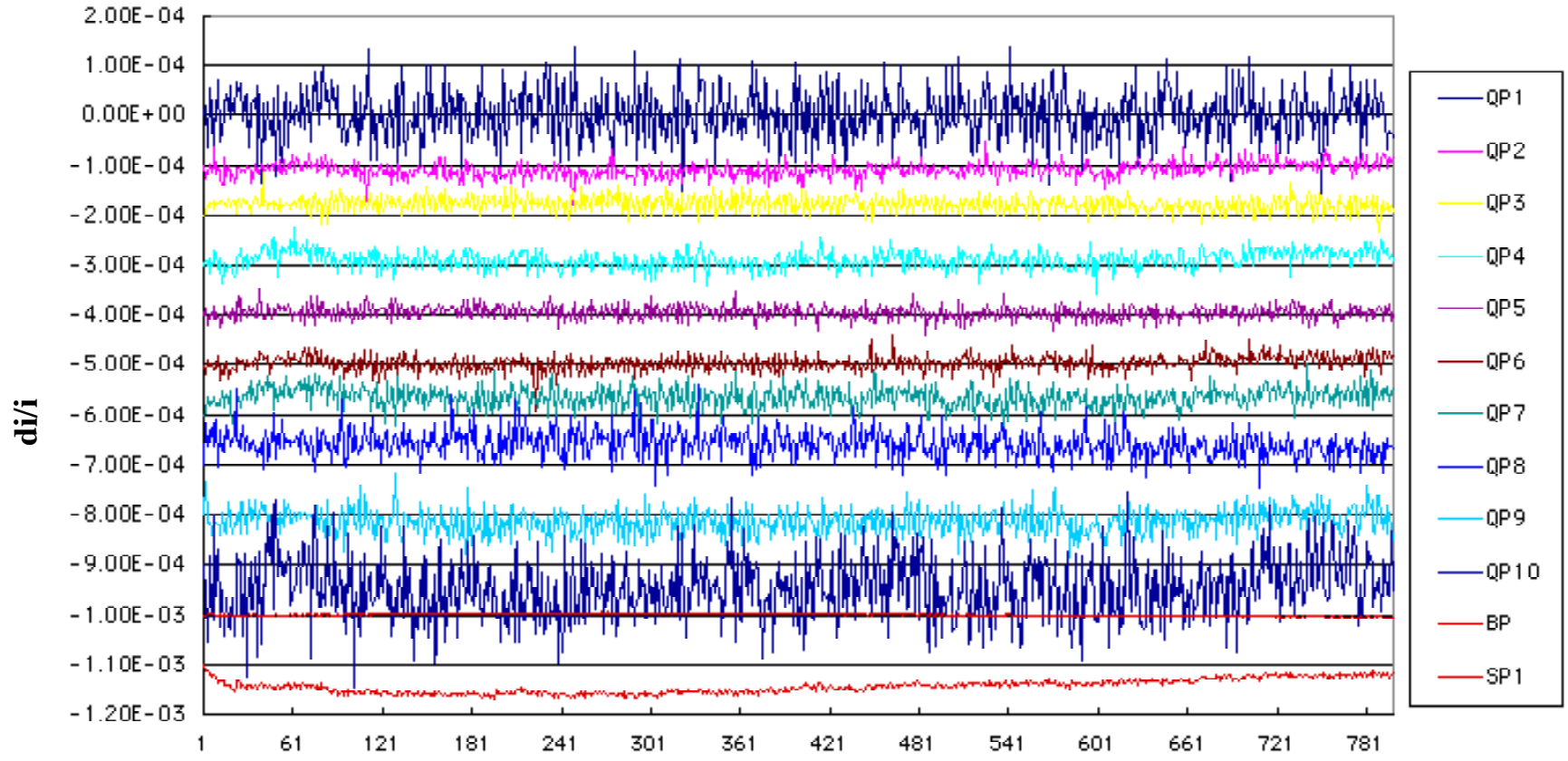
- BP: No Change
- SP: (Mos-FET, Digital Feedback) 9% Voltage Down
  --> ROM exchange
- QP: (Thyrister Phase Control) 9%, 25% Voltage Down
  --> Tuned

Q magnet Power Supply Tuning and Modification History

- 2000 Aug. 23-30 ; Thyrister Phase Tuning
- 2000 Sep. 8-10 ; Input Transformer adopted
- 2000 Oct. 2- 3 ; Phase Timing Circuit Modify
- 2001 May 8-10 ; DCCT exchange
- 2002 Jan. ; Phase Control Circuit Modify

QP, BP, SP Drift (Before Tuning)

after LSS30m SR Modify in 2000 Aug.



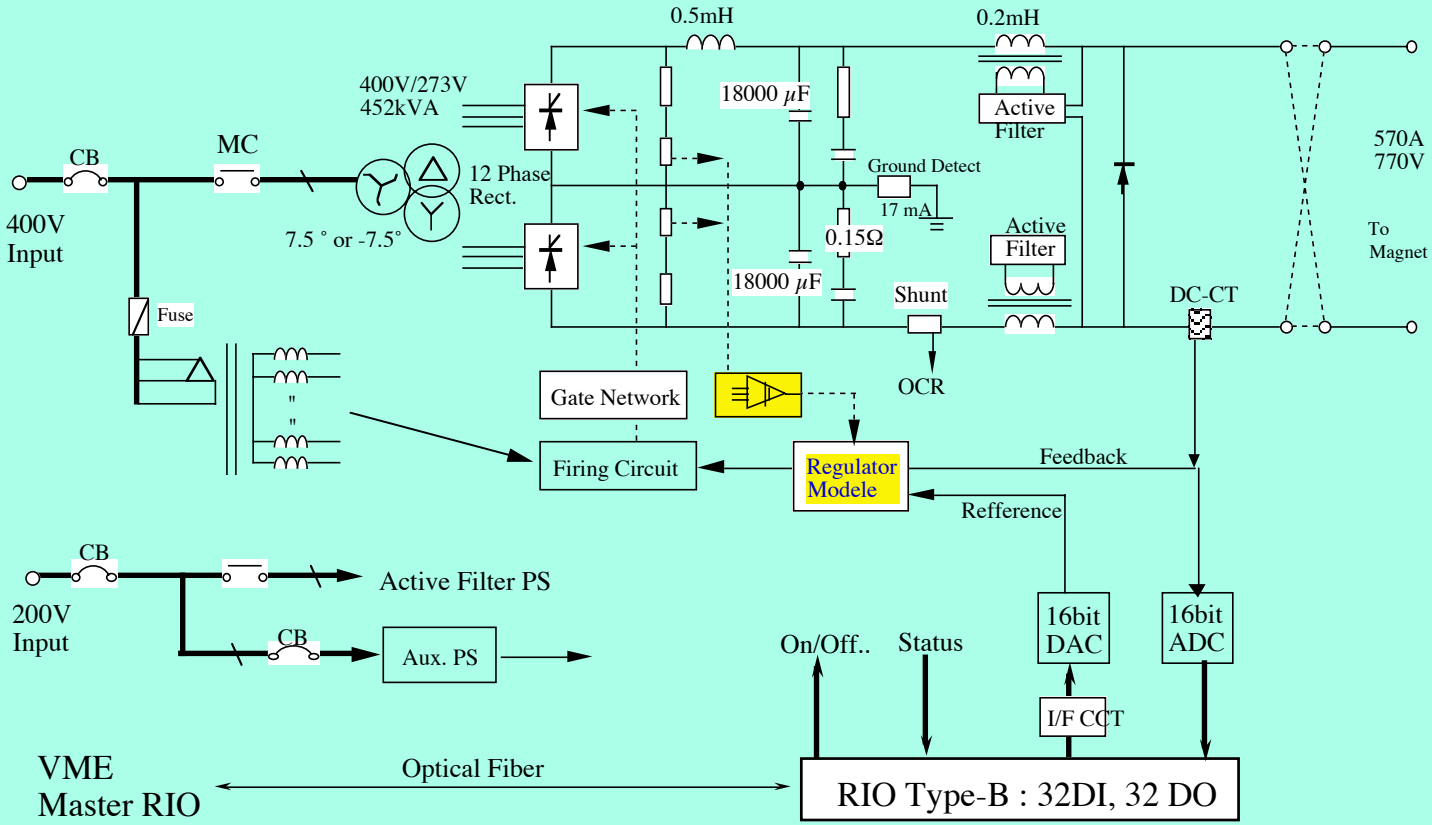
Time (min/point) 2000 Sep.5th 11:40~ 6th 01:33

QP Current Control Circuit Tuned and Modified

2000 Oct.

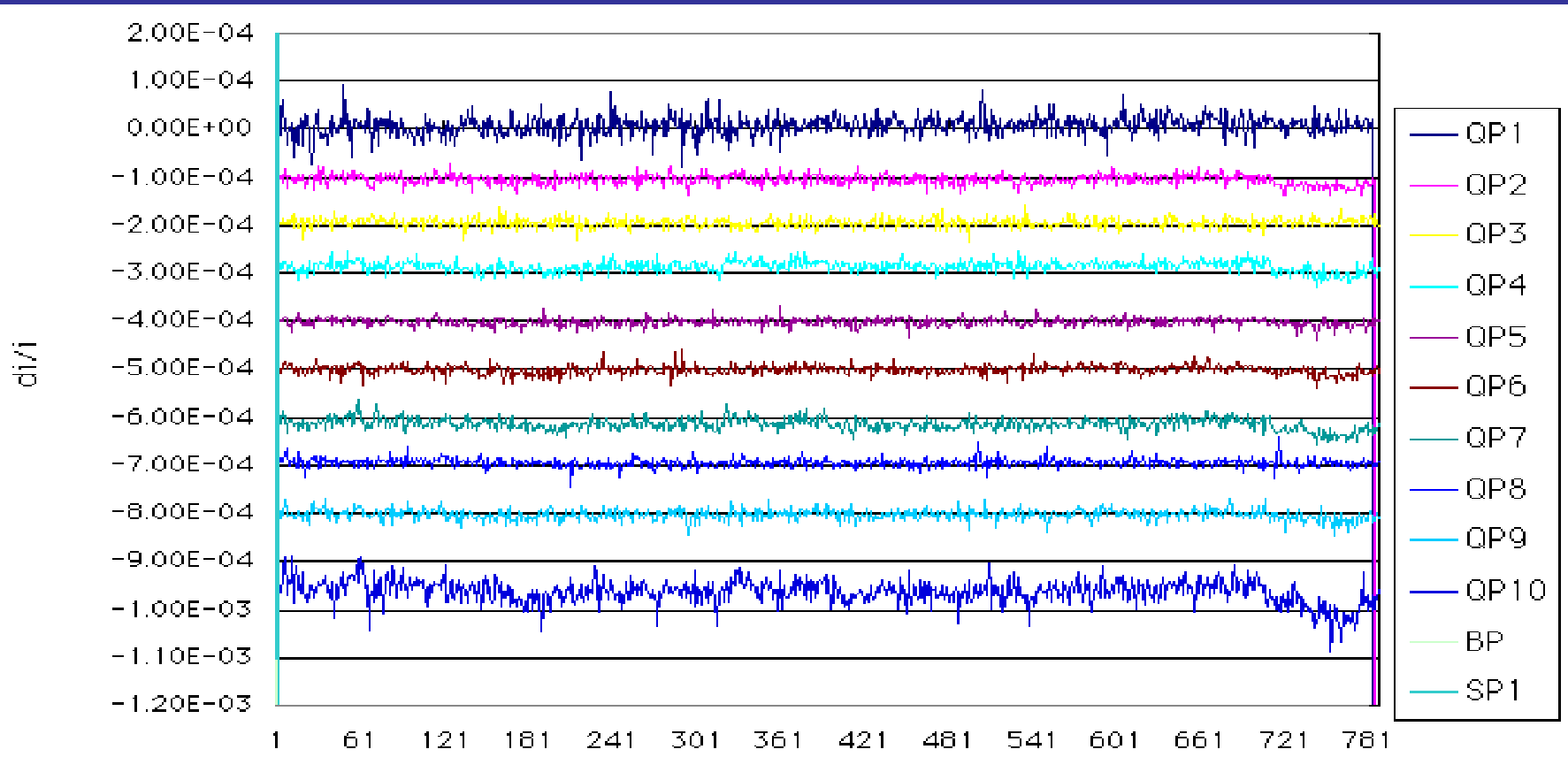
Q-PS Firing Circuit Modification

Stability --> 2*10E-5 2001.Jan.6



QP Drift after Raff Tuning

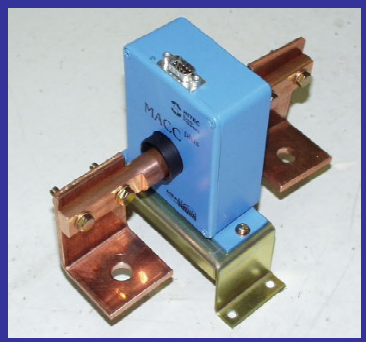
in 2000.9.11



Time (min/point) 2000 Sep.10th 19:16~ 11th 8:57

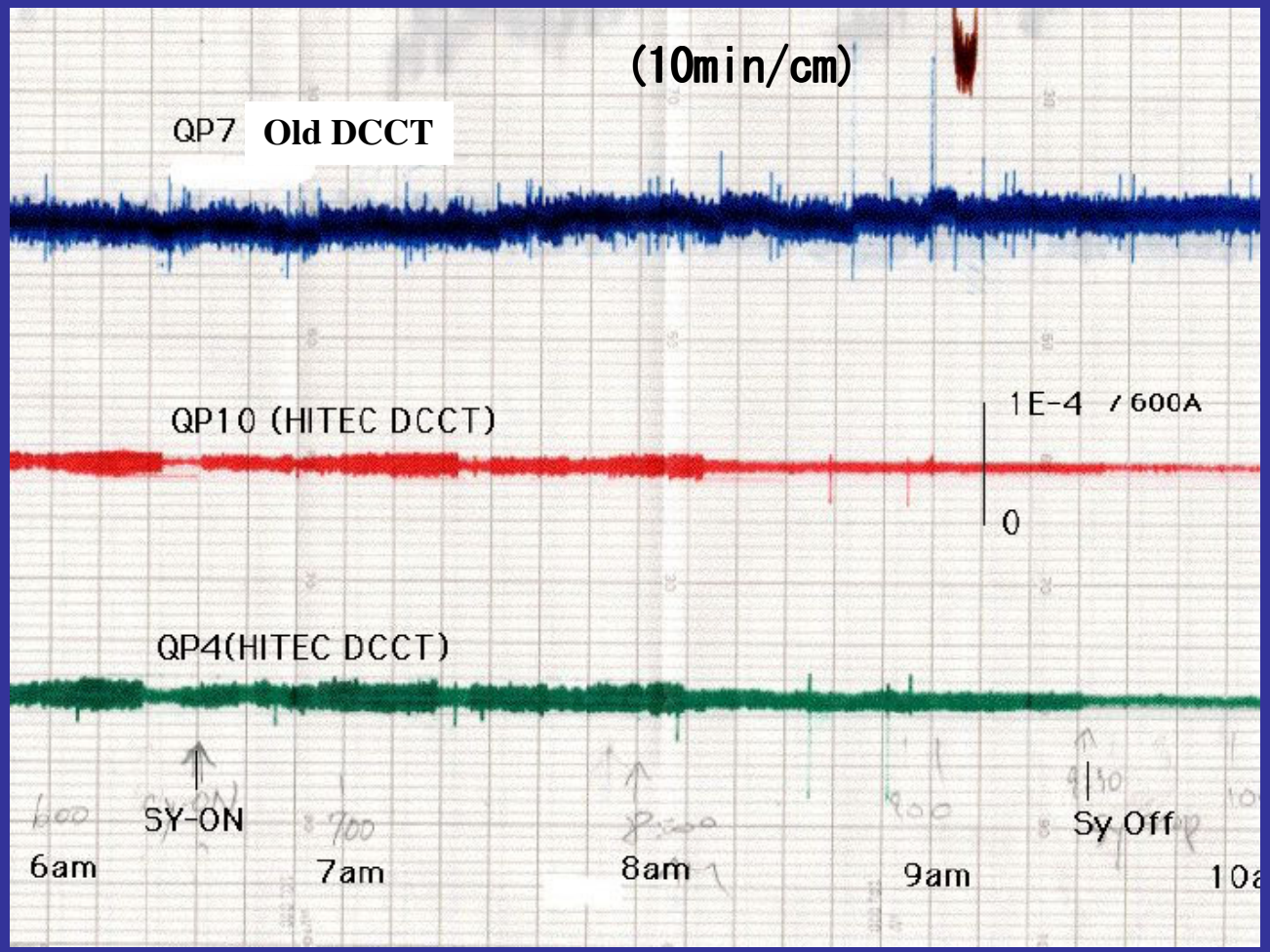
QP Modify

DCCT --> HITEC MACC+ in 2001.May 08



4-Pen Recorder Chart Graph of QP:DCCT(offset by SVG) Drifts, at Synchrotron Operation

May.2001



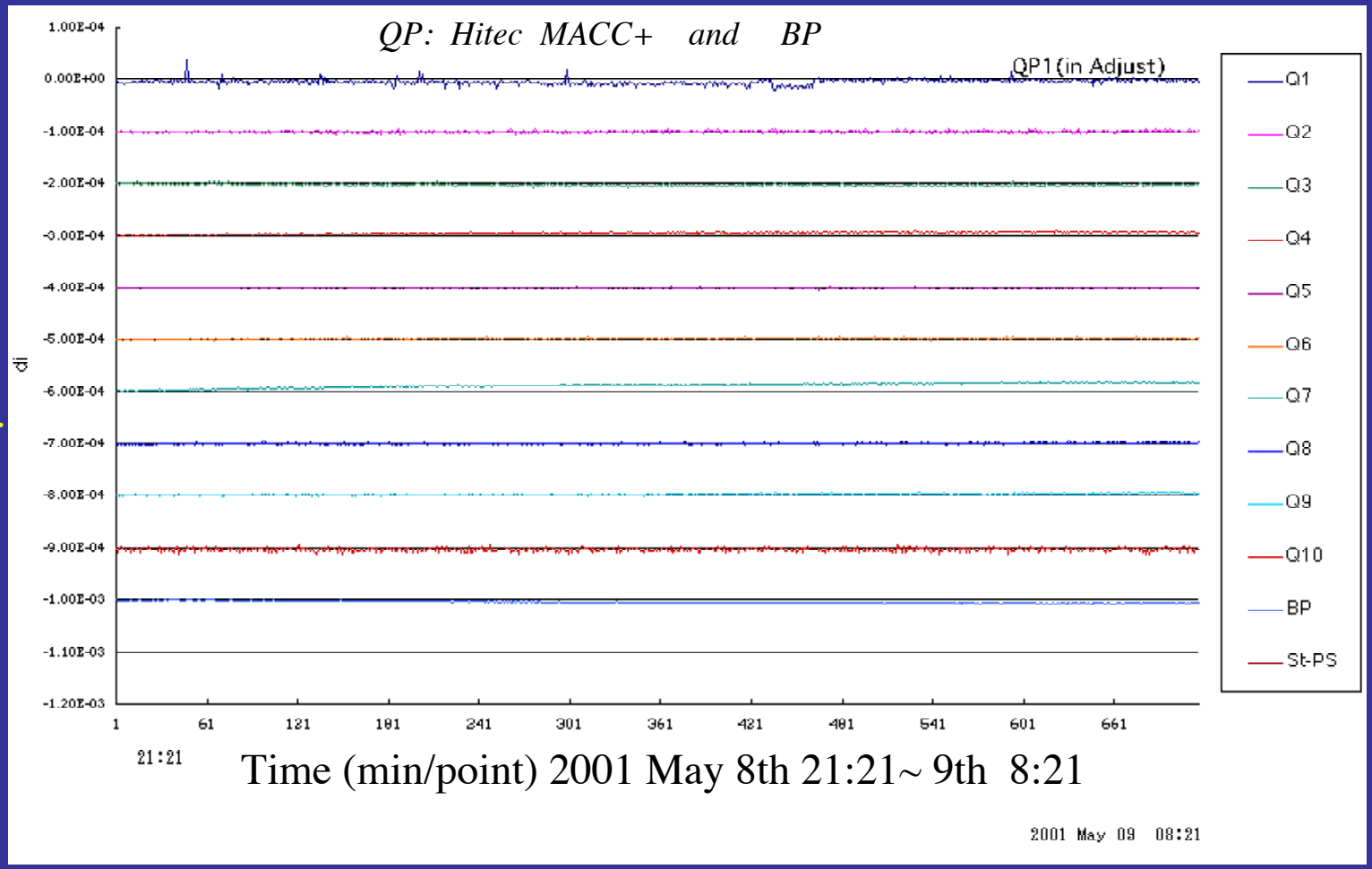
60 ppm

10 ppm

QP Drift (after Tuning #3)

in 2001.May 08

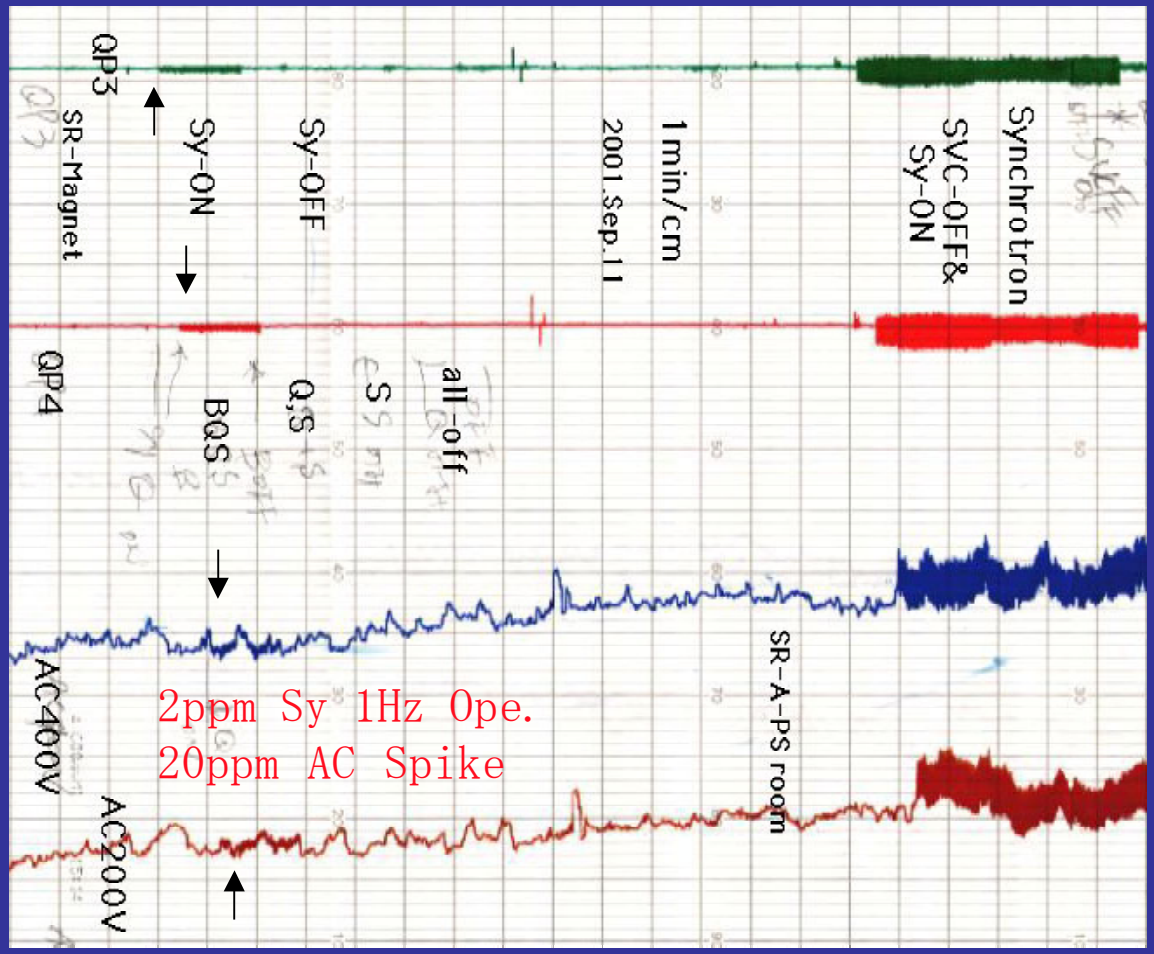
100 ppm / dev.



4-Pen Recorder Chart Graf

Sep. 11. 2001

Corresponding to the Synchrotron Magnets PS On/Off and SVC On/Off



QP3/SR

QP4/SR

AC400V/SR

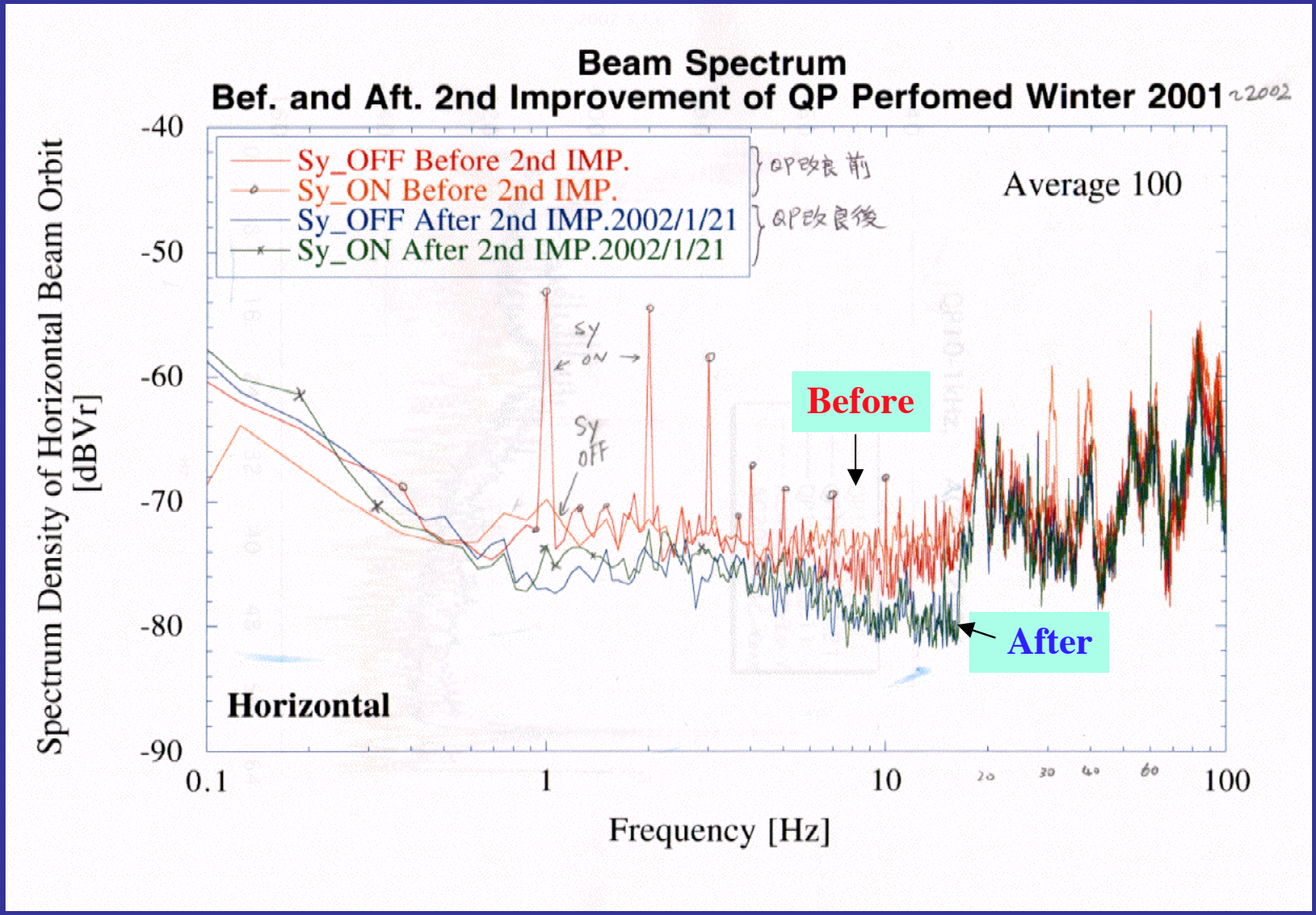
Spike 0.6-1 %

AC200V/SR

DCCT-SVG

(1 min/cm)

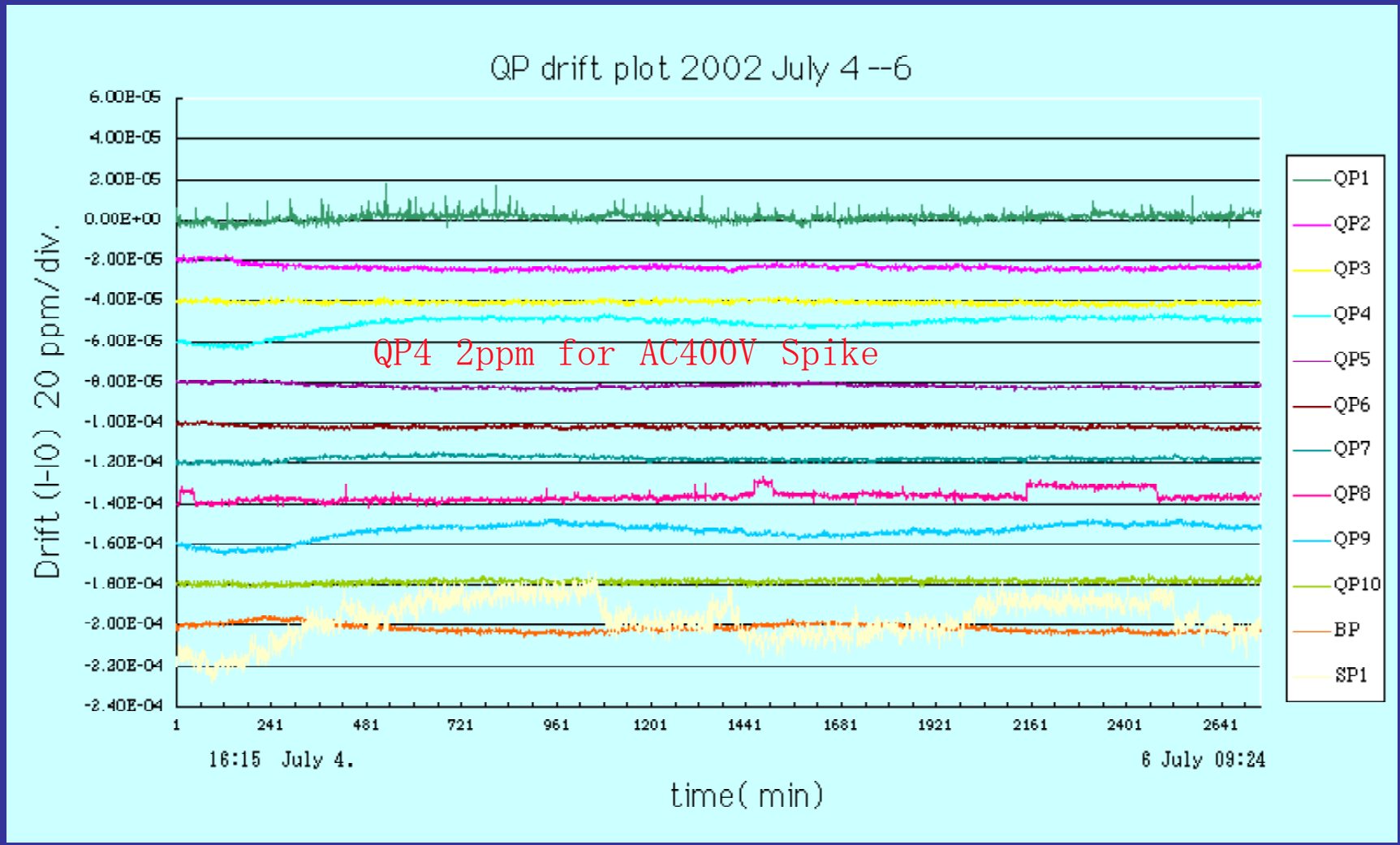
Beam Spectrum 2001 and 2002

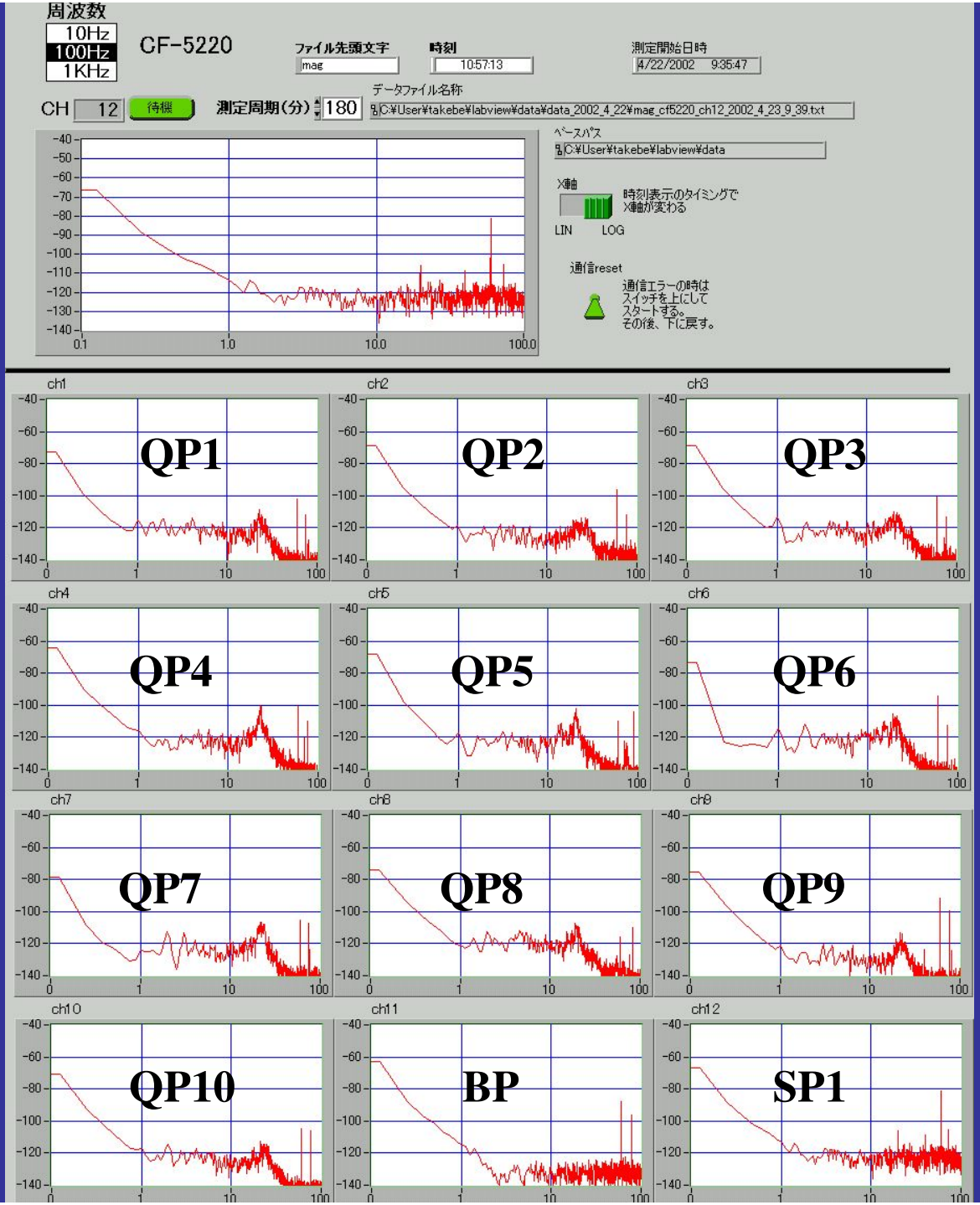


QP 2 days drift (after Tuning #5)

in 2002 Jul.4-6

20 ppm /dev.





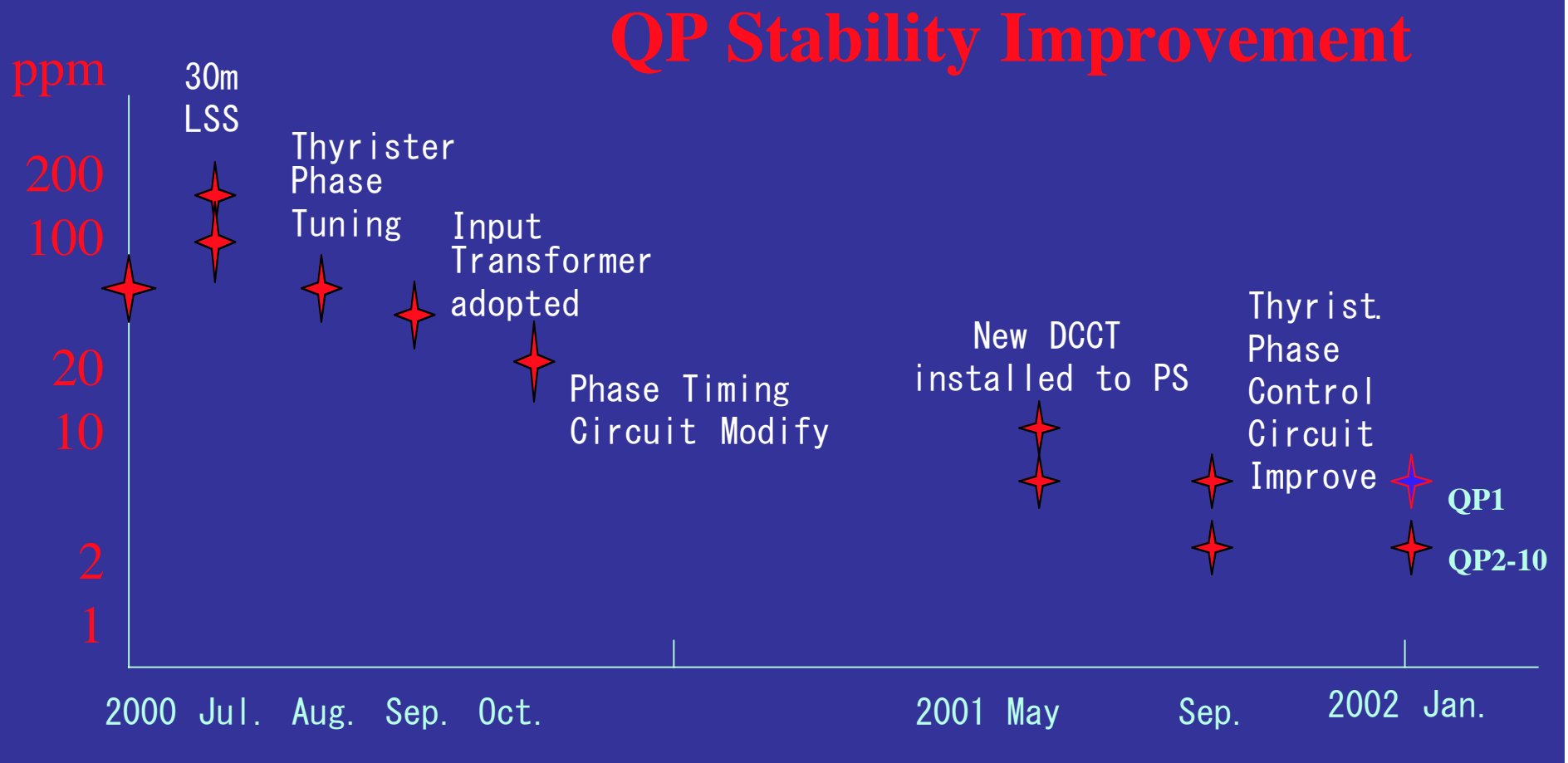
Ripple (1--100Hz)

in 2002 April

FFT Scans 10 QPs , BP, SP

-100dBv= 1ppm/600A.

Conclusion of Part 1



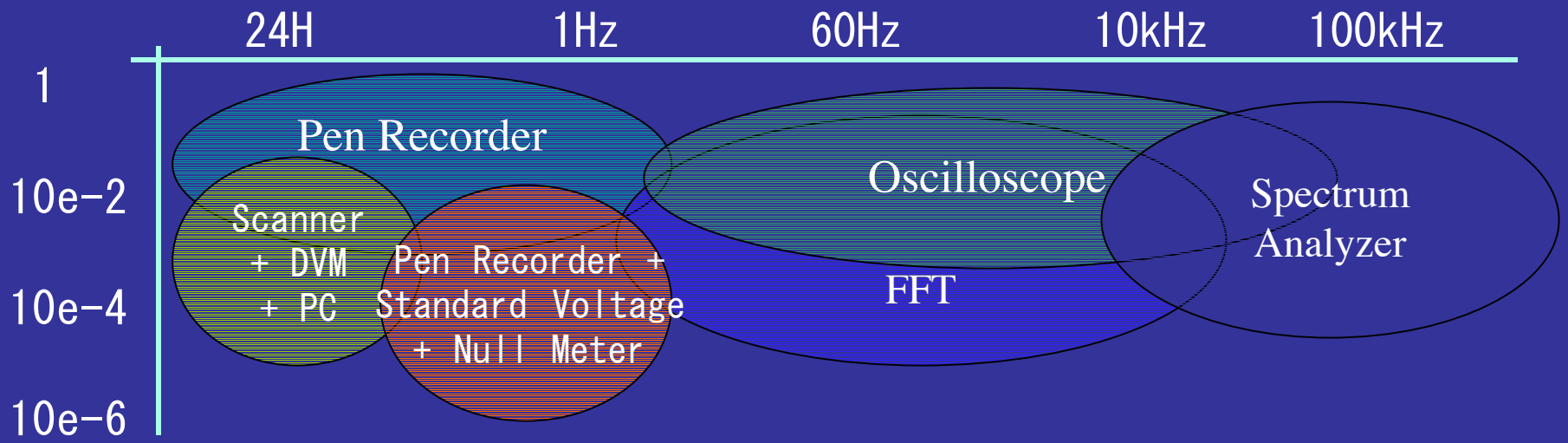
Magnet Current Check device: DCCT Accuracy:

HITEC (HOLEC);
TOPACC ; Zero Flux..

0...10Hz < 0.1 ppm
0...100Hz < 0.5 ppm
0--10kHz < 1.5 ppm

DC Accuracy < 0.5 ppm
1 ppm/K
5 ppm/year
Linearity error < 2.5 ppm

Current/Voltage Measurement System resolution and accuracy



FFT Scans All PSs.

GPIB-->PS--> WS-->Database

Monitor all Year and compare to the beam

Hi-Precision Magnet Current and Voltage Monitoring System Specification

Device ,	Accuracy	Freq.	Time Range
1) Scanner + DVM ,	10E-5	f < 0. 3Hz	Week, Year
2) SVG+Pen Recorder,	10E-6	f < 2～3Hz	Hrs
		We developed convenient system in low price.	
3) FFT	10E-6	1Hz < f	Hrs, Day
4) Filter-Amp. E/O-O/E	10E-4	0.1Hz < f	(to Beam Diagnostic Room)

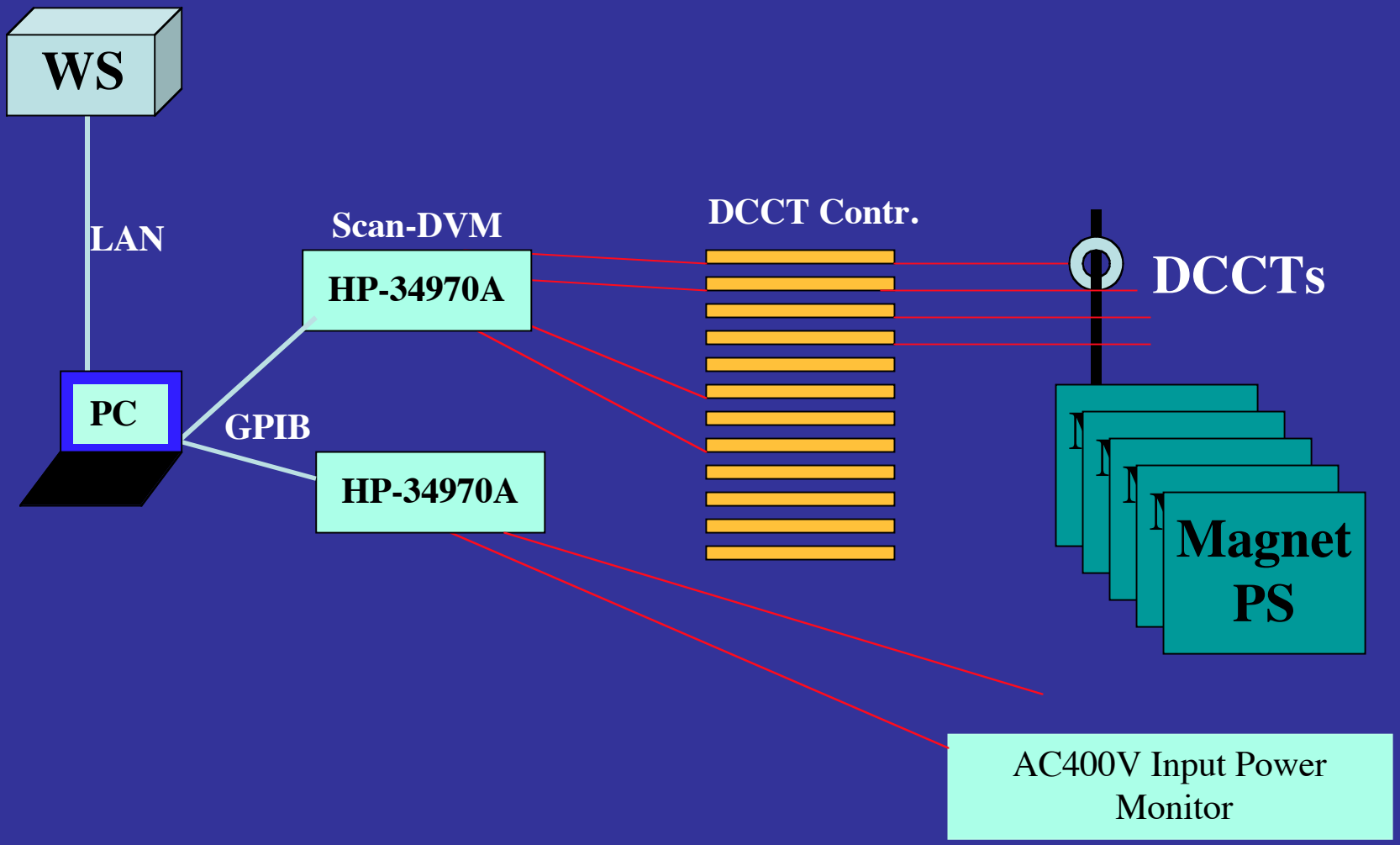
Required Stability of Magnets

Magnet:	PS Spec. '91	Achieve '97-'99	Now 2002
BP:	100ppm	10ppm	10 ppm
QP:	100	40	2- 5
SP:	100	50	50

Required Stability become smaller, because the other sources (monitors, temperature,,) were reduced at the SPring-8.

1) Scanner + DVM (slow)

Actual Stability < 3 ppm / Year



DCCT Amp., 4 pen Recorder, SVG and DVM+Scanner

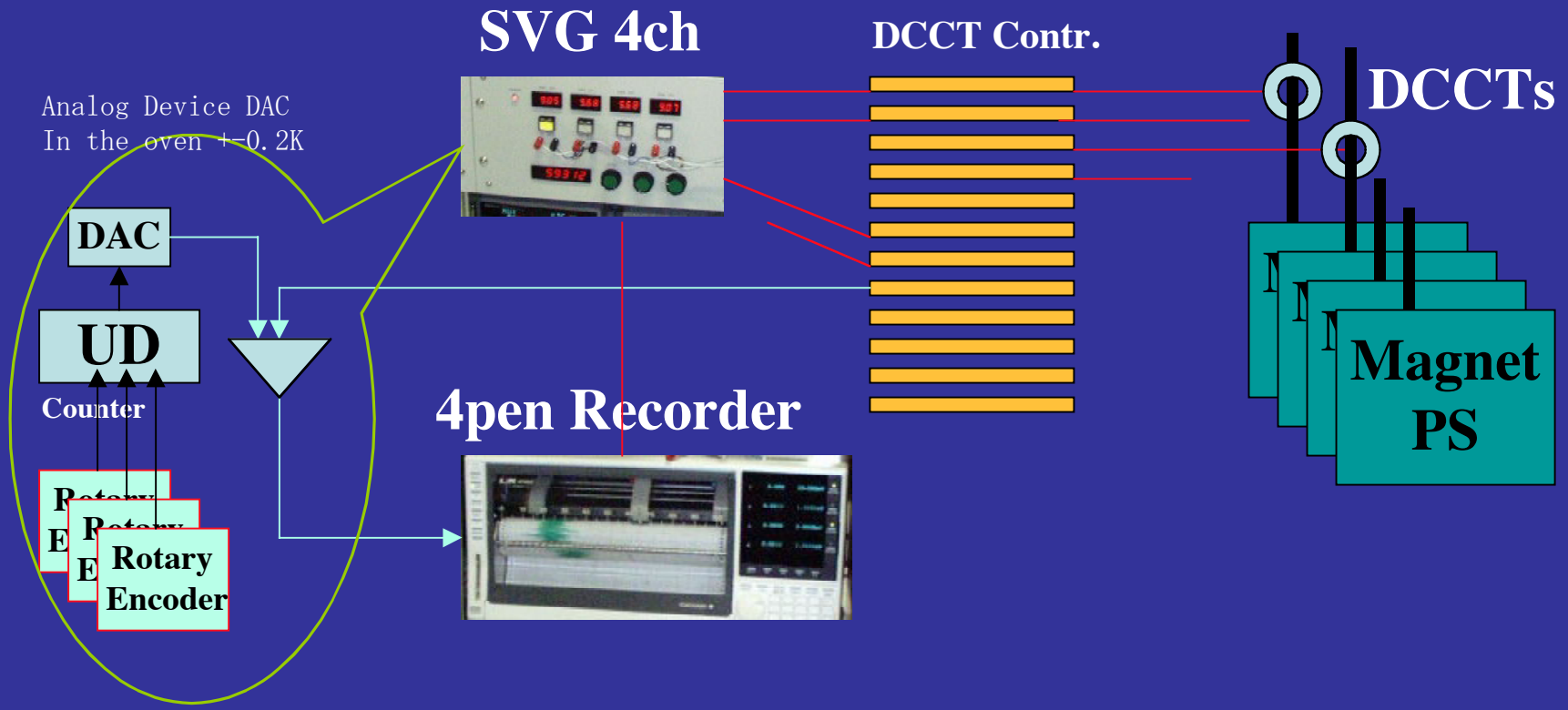
2000.2

DCCT Head (TOPACC)

2) 4ch SVG (Stable Voltage Generator)+4 Pen Recorder

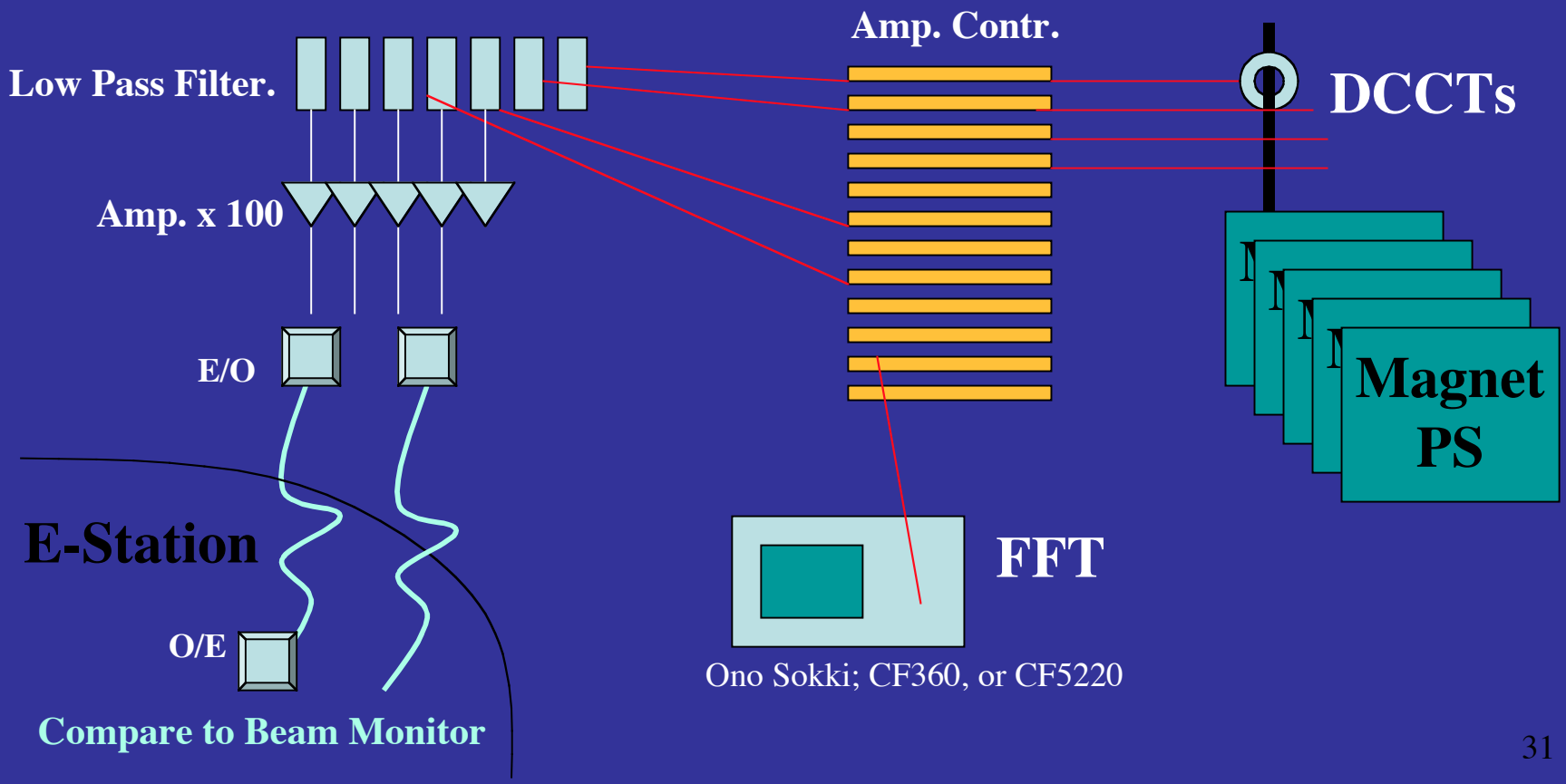
Absolute	10E-4	
Reference	2*10E-6	
freq.	＜２～３Hz	Conventional;
Low Price	4ch 1M yen(2k$/ch)	1ch 1-4MYen ($8k-- $ 30k)

We developed convenient system using Rotary Encoder



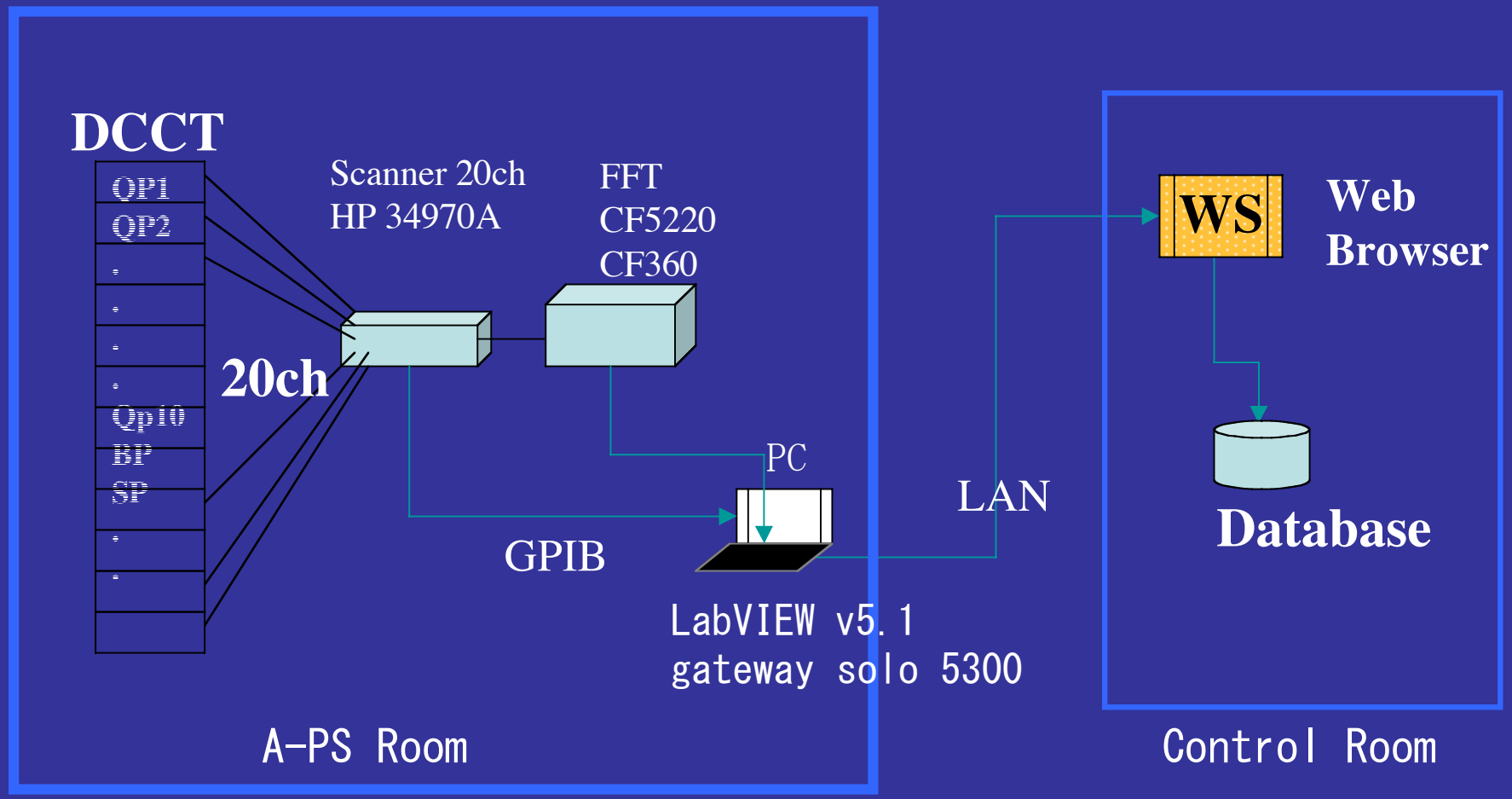
3) FFT f> 1Hz Ripple 1x10E-6

4) Filter-Amp.+ E/O O/E to E-station 10E-4



3) FFT + PC Data Logging System

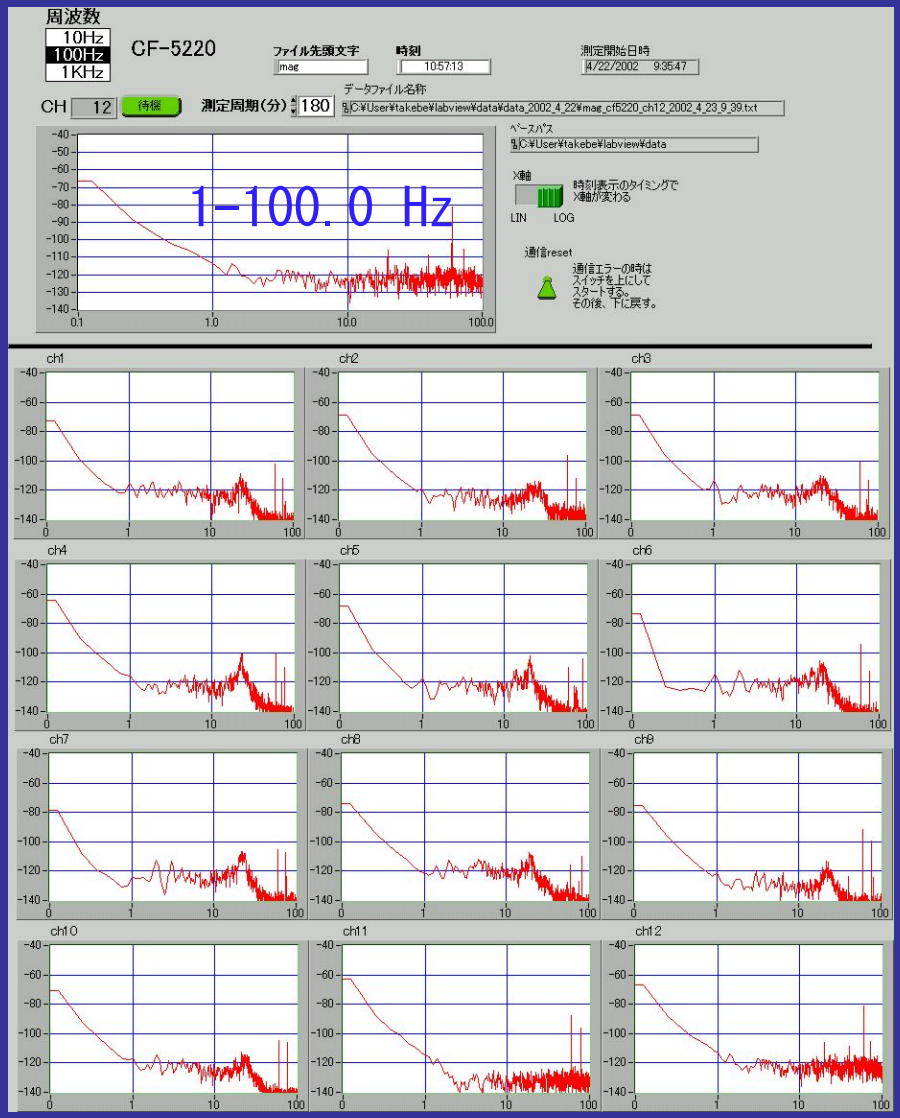
2002.May



3) FFT Scan
PC Display
(LabView 5.1)

QP1,,10, BP,
and SP1
Current FFT

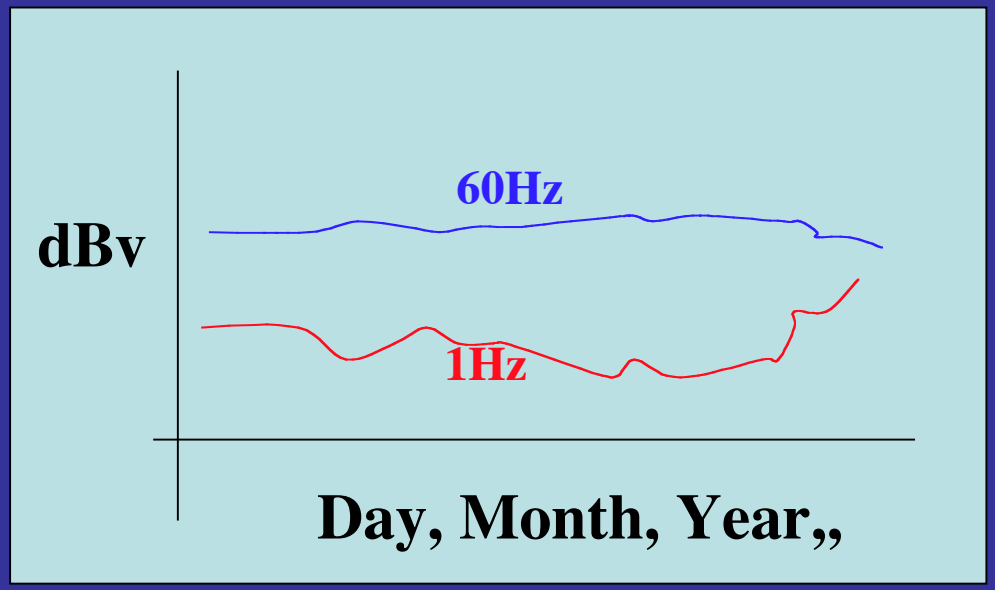
Web Browser through LAN

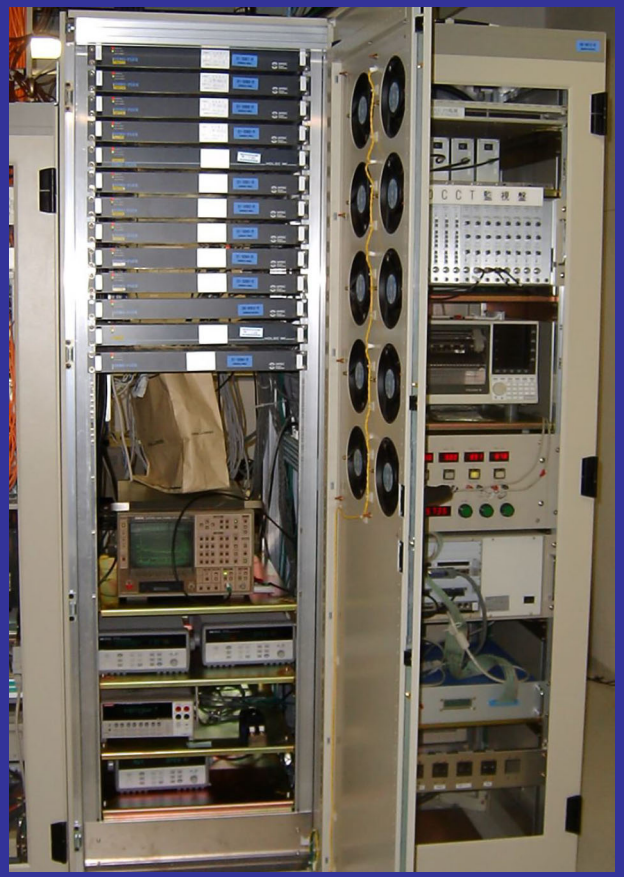


Next Stage #1

Now We are developing (2002-2003)

FFT Data --> Frequency Component will be Logged displayed using the SPring-8 Database System.





Next Stage #2

2003--

Number of Monitor PSs will be increased.
(i.e.
SPs and QAs QLP, SLPs in ABCD-Zone,)

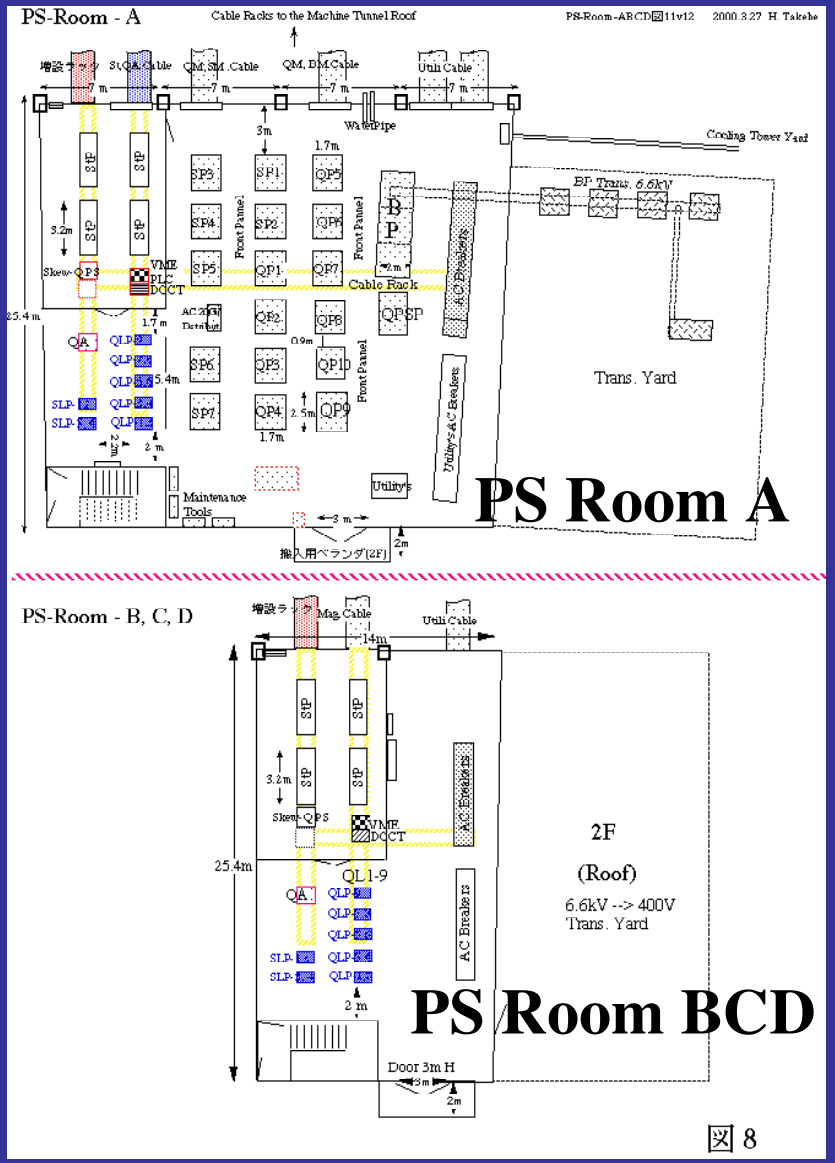


図 8

Summary

1. **Four Types of Convenient Checking systems for Magnet Current Drift were developed.**

2. **Magnet Currents FFT scan Program (every 3Hrs) and Check Precisely and Logged (Long, Mid, Short term) to the Database system.**

3. **QP response and stability were improved against 1Hz and Power Station's Tap change (slow and fast) to 2~5 ppm.**